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EXAMINER:	Elizabeth A. Bolden
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INVENTOR:	Ulrich PEUCHERT and Peter BRIX
TITLE:	A FLAT PANEL LIQUID-CRYSTAL DISPLAY SUCH AS FOR A LAPTOP COMPUTER

Greensburg, Pennsylvania 15601

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

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TRANSLATOR'S VERIFICATION

Sir:

I, Nils H. Ljungman, a patent attorney with Registration No. 25,997, registered to practice before the U.S. Patent and Trademark Office and an attorney-at-law with Registration No. 11328, registered to practice before the Supreme Court of Pennsylvania, declare that I am proficient in both the English and the German languages and am able to make accurate translations of patent and trademark subject matter from German into English. I have verified the translation of Federal Republic of Germany Patent Application No. 100 00 837, and I believe that the attached translation is an accurate, verified and true

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translation of the German language copy of Federal Republic of Germany Patent Application No. 100 00 837.

The undersigned declares further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the Unites States Code and that such willful false statements may jeopardize the validity of the applications or any patents issuing thereon.

(Signature) Nils H. Ljungman

Nils H. Ljungman, Esq.
Patent Attorney
Attorney-at-Law

(Date) January 12, 2004

Patent Claims

1. Alkali-free aluminoborosilicate glass having a coefficient of thermal expansion $\alpha_{20/300}$ of between $2.8 \cdot 10^{-6}/K$ and $3.8 \cdot 10^{-6}/K$, which has the following composition (in % by weight, based on oxide):

SiO_2	> 58 - 65
B_2O_3	> 6 - 11.5
Al_2O_3	> 14 - 25
MgO	4 - 8
CaO	0 - 8
SrO	2.6 - < 4
BaO	0 - < 0.5
with SrO + BaO	> 3
ZnO	0 - 2

2. Alkali-free aluminoborosilicate glass having a coefficient of thermal expansion $\alpha_{20/300}$ of between $2.8 \cdot 10^{-6}/K$ and $3.4 \cdot 10^{-6}/K$, which has the following composition (in % by weight, based on oxide):

SiO_2	> 58 - 65
B_2O_3	> 6 - 11.5
Al_2O_3	> 14 - 25
MgO	4 - 8
CaO	0 - < 2
SrO	> 0.5 - < 4
BaO	0 - < 0.5
ZnO	0 - 2

3. Alkali-free aluminoborosilicate glass having a coefficient of thermal expansion $\alpha_{20/300}$ of between $2.8 \cdot 10^{-6}/K$ and $3.6 \cdot 10^{-6}/K$, which has the following composition (in % by weight, based on oxide):

SiO_2	> 58 - 65
B_2O_3	> 6 - 11.5
Al_2O_3	> 21 - 25
MgO	4 - 8
CaO	0 - 8
SrO	2.6 - < 8
BaO	0 - < 0.5
with SrO + BaO	> 3
ZnO	0 - 2

4. Aluminoborosilicate glass according to Claim 1 or 2, characterized in that it comprises more than 18% by weight, preferably at least 20.5% by weight, particularly preferably at least 21% by weight, of Al_2O_3.

5. Aluminoborosilicate glass according to at least one of Claims 1 to 4, characterized in that the glass comprises more than 8% by weight of B_2O_3.

6. Aluminoborosilicate glass according to at least one of Claims 1 to 5, characterized in that it additionally comprises:

ZrO_2	0 - 2
TiO_2	0 - 2
with ZrO_2 + TiO_2	0 - 2
As_2O_3	0 - 1.5
Sb_2O_3	0 - 1.5
SnO_2	0 - 1.5
CeO_2	0 - 1.5
Cl^-	0 - 1.5
F^-	0 - 1.5
SO_4^{2-}	0 - 1.5
with As_2O_3 + Sb_2O_3 + SnO_2 + CeO_2 + Cl^- + F^- + SO_4^{2-}	0 - 1.5

7. Aluminoborosilicate glass according to at least one of Claims 1 to 6, characterized in that the glass is free of arsenic oxide and antimony oxide, apart from unavoidable impurities, and that it can be produced in a float plant.

8. Aluminoborosilicate glass according to at least one of Claims 1 to 7, which has a coefficient of thermal expansion $\alpha_{20/300}$ of between $2.8 \cdot 10^{-6}$/K and $3.6 \cdot 10^{-6}$/K, a glass transition temperature Tg of > 700°C and a density ρ of < 2.600 g/cm^3.

9. Use of the aluminoborosilicate glass according to at least one of Claims 1 to 8 as substrate glass in display technology.

10. Use of the aluminoborosilicate glass according to at least one of Claims 1 to 8 as substrate glass in thin-film photovoltaics.

Alkali-free aluminoborosilicate glasses, and uses thereof

The invention relates to alkali-free aluminoborosilicate glasses. The invention also relates to uses of these glasses.

High requirements are made of glasses for applications as substrates in flat-panel liquid-crystal display technology, for example in TN (twisted nematic)/STN (supertwisted nematic) displays, active matrix liquid crystal displays (AMLCDs), thin film transistors (TFTs) or plasma addressed liquid crystals (PALCs). Besides high thermal shock resistance and good resistance to the aggressive chemicals employed in the process for the production of flat-panel screens, the glasses should have high transparency over a broad spectral range (VIS, UV) and, in order to save weight, a low density. Use as substrate material for integrated semiconductor circuits, for example in TFT displays ("chip on glass") in addition requires thermal matching to the thin-film material silicon which is usually deposited on the glass substrate in the form of amorphous silicon (a-Si) at low temperatures of up to 300°C. The amorphous silicon is partially recrystallized by subsequent heat treatment at temperatures of about 600°C. Owing to the a-Si fractions, the resulting, partially crystalline poly-Si layer is characterized by a thermal expansion coefficient of $\alpha_{20/300} \cong 3.7 \cdot 10^{-6}/K$. Depending on the a-Si/poly-Si ratio, the thermal expansion coefficient $\alpha_{20/300}$ may vary between $2.9 \cdot 10^{-6}/K$ and $4.2 \cdot 10^{-6}/K$. When substantially crystalline Si layers are generated by high temperature treatments above 700°C or direct deposition by CVD processes, which is likewise desired in thin-film photovoltaics, a substrate is required which has a significantly reduced thermal expansion of $3.2 \cdot 10^{-6}/K$ or less.

In addition, applications in display and photovoltaics technology require the absence of alkali metal ions. Sodium oxide levels of less than 1000 ppm as a result of production can be tolerated in view of the generally "poisoning" action due to diffusion of Na^+ into the semiconductor layer.

It should be possible to produce suitable glasses economically on a large industrial scale in adequate quality (no bubbles, knots, inclusions), for example in a float plant or by drawing methods. In particular, the production of thin (< 1 mm) streak-free substrates with low surface undulation by drawing methods requires high devitrification stability of the glasses. Compaction of the substrate during production, in particular in the case of TFT displays, which has a disadvantageous effect on the semiconductor microstructure, can be countered by establishing a suitable temperature-dependent viscosity characteristic line of the glass: with respect to thermal process and shape stability, it should have a sufficiently high glass transition temperature T_g, i.e. $T_g > 700°C$, while on the other hand not having excessively high melting and processing (V_A) temperature, i.e. a V_A of $\leq 1350°C$.

The requirements of glass substrates for LCD display technology or thin-film photovoltaics technology are also described in "Glass substrates for AMLCD applications: properties and implications" by J. C. Lapp, SPIE Proceedings, Vol. 3014, invited paper (1997), and in "Photovoltaik - Strom aus der Sonne" by J. Schmid, Verlag C. F. Müller, Heidelberg 1994, respectively.

The abovementioned requirement profile is fulfilled best by alkaline earth metal aluminoborosilicate glasses. However, the known display or solar cell

substrate glasses described in the following publications still have disadvantages and do not meet the full list of requirements:

Numerous documents describe glasses having low MgO contents: JP 9-169 538 A, JP 4-160 030 A, JP 9-100 135 A, EP 714 862 A1, EP 341 313 B1, US 5,374,595, WO 97/11919 and WO 97/11920. Such glasses, in particular those of EP 714 862 A1 and JP 9-169538 A, do not have the desired meltability, as is evident from very high temperatures at viscosities of 10^2 dPas and 10^4 dPas, and have a relatively high density. The same applies to the MgO-free glasses of DE 37 30 410 A1.

The glasses of US 5,374,595 have high BaO contents of 2 - 7 mol% which leads to undesirably high densities of these glasses. The same applies to the glasses of JP 61-132536 A, JP 8-295530 A, JP 9-48632 A and JP 9-156953 A.

Similarly, the glasses of JP 10-72237 A having high SrO contents have very high temperatures at viscosities of 10^2 dPas and 10^4 dPas, as is evident from the examples.

The same is true for glasses having low B_2O_3 contents as described in JP 9-263421 A and JP 10-45422 A. The devitrification tendency will be disadvantageously high, in particular in combination with low BaO contents. On the other hand, excessively high B_2O_3 contents - such glasses are described, for example, in US 4,824,808 - are disadvantageous for the intended properties of high heat resistance and high chemical resistance, in particular to hydrochloric acid solutions.

Low-SiO_2 glasses do not have sufficient chemical resistance either, in particular when they contain relatively large amounts of B_2O_3 and are low in alkaline

earth metals. This applies to the glasses of WO 97/11919 and EP 672 629 A2. The relatively SiO_2-rich variants of the latter document have only low Al_2O_3 levels, which is disadvantageous for the cristallization behaviour.

JP 9-123 33 A, which relates to glasses for hard disks, describes compositions of SiO_2, Al_2O_3, CaO and further optional components including B_2O_3. The glasses listed have high alkaline earth metal oxide contents and thus have high thermal expansion, which makes them unsuitable for use in LCD or PV technology. Their visual quality will probably also be inadequate.

DE 196 17 344 C1 and DE 196 03 698 C1 by the Applicant disclose alkali-free, tin oxide-containing, low-SiO_2 or SrO-free glasses having a coefficient of thermal expansion $\alpha_{20/300}$ of about $3.7 \cdot 10^{-6}$/K and very good chemical resistance. They are suitable for use in display technology. However, since they must contain ZnO, they are not ideal, in particular for processing in a float plant. In particular at higher ZnO contents (> 1.5% by weight), there is a risk of formation of ZnO coatings on the glass surface by evaporation and subsequent condensation in the hot-shaping range.

WO 98/27019 describes glasses for display and photovoltaics applications having a low density and a high heat resistance. In these glasses, some of which have a high CaO content, the SrO and BaO contents are limited to a total of 3% by weight, which renders the glasses susceptible to crystallization.

DE 196 01 022 A1 describes glasses which are selected from a very wide composition range and which must contain ZrO_2 and SnO. The glasses, which, according to the examples, have a relatively high BaO content, tend

to exhibit glass defects because of the ZrO_2 level which has to be present.

DE 42 13 579 describes glasses for TFT applications having a coefficient of thermal expansion $\alpha_{20/300}$ of $< 5.5 \cdot 10^{-6}$/K, according to the examples of $\geq 4,0 \cdot 10^{-6}$/K. These glasses which have relatively high B_2O_3 levels and relatively low SiO_2 contents do not have a high chemical resistance, in particular to diluted hydrochloric acid.

In the unexamined Japanese publications JP 10-25132 A, JP 10-114538 A, JP 10-130034 A, JP 10-59741 A, JP 10-324526 A, JP 11-43350 A, JP 11-49520 A, JP 10-231139 A and JP 10-139467 A, mention is made of very wide composition ranges for display glasses, which can be varied by means of many optional components and which are admixed with one or more specific refining agents in each case. However, these documents do not indicate how glasses having the complete requirement profile described above can be obtained in a specific manner.

It is an object of the present invention to provide glasses which meet said physical and chemical requirements imposed on glass substrates for liquid-crystal displays, in particular for TFT displays, and for thin-film solar cells, in particular on the basis of μc-Si, glasses which have high heat resistance, a favourable processing range and sufficient devitrification stability.

The object is achieved by aluminoborosilicate glasses as defined in the independent Claims.

The glasses contain from > 58 to 65% by weight of SiO_2. At a lower content, the chemical resistance is impaired, while at a higher content, the thermal expansion is too low and the crystallization tendency

of the glass increases. Preference is given to a content of up to 64.5% by weight of SiO_2.

The glasses contain from > 14 to 25% by weight of Al_2O_3. Al_2O_3 has a positive effect on the heat resistance of the glasses without excessively increasing the processing temperature. At a lower content, the glasses become more susceptible to crystallization. Preference is given to a content of more than 14.5% by weight of Al_2O_3, particularly preferably more than 18% by weight of Al_2O_3, most preferably of at least 20.5% by weight of Al_2O_3, in particular of at least 21% by weight of Al_2O_3. Preference is given to a maximum Al_2O_3 content of 24% by weight.

The B_2O_3 content is restricted to a maximum of 11.5% by weight in order to achieve a high glass transition temperature T_g. Higher contents would also impair the chemical resistance. Preference is given to a maximum B_2O_3 content of 11% by weight. The B_2O_3 content is higher than 6% by weight to ensure that the glasses have good meltability and good crystallization stability. Preference is given to a minimum content of more than 8% by weight.

The network-forming components Al_2O_3 and B_2O_3 are preferably present at mutually dependent minimum levels, ensuring a preferred content of the network formers SiO_2, Al_2O_3 and B_2O_3. For example, in the case of a minimum B_2O_3 content of > 6% by weight, the minimum Al_2O_3 content is preferably > 18% by weight, and in the case of a minimum Al_2O_3 content of > 14% by weight, the minimum B_2O_3 content is preferably > 8% by weight.

The sum of SiO_2, Al_2O_3 and B_2O_3 is preferably between 83 and 91% by weight.

An essential glass component are the network-modifying alkaline earth metal oxides. In particular by varying their levels, a coefficient of thermal expansion $\alpha_{20/300}$ of between $2.8 \cdot 10^{-6}/K$ and $3.8 \cdot 10^{-6}/K$ is achieved. The individual oxides are present in the following proportions:

The glasses contain from 4 to 8% by weight of MgO. A high MgO level has a positive effect on the desired properties of low density and low processing temperature, whereas a rather low level favours crystallization stability and chemical resistance.

The glasses may contain up to 8% by weight of CaO. Higher levels would lead to an excessive increase in thermal expansion and a decrease in crystallization stability. For glasses exhibiting a particularly low thermal expansion, i.e. in particular for glasses having coefficients of thermal expansion $\alpha_{20/300}$ of up to $3.4 \cdot 10^{-6}/K$, the CaO content is preferably limited to a maximum of < 2% by weight.

Another optional constituent is BaO, its maximum content being limited to less than 0.5% by weight. This ensures good meltability and keeps the density low. The glass is preferably BaO-free.

The glass contains up to < 4% by weight of the relatively heavy alkaline earth metal oxide SrO. Limitation to this low maximum content is especially advantageous for a low density of the glass.

When the minimum sum of SrO and BaO is more than 3% by weight in order to ensure sufficient crystallization stability, in particular with rather CaO-rich compositions, the minimum SrO content is 2.6% by weight.

In the case of low-CaO and CaO-free variants, in particular at CaO contents of between 0 and < 2% by weight, a minimum SrO content of at least > 0.5% by weight is sufficient. In the case of these glasses, the sum of SrO and BaO is preferably at least 1% by weight, particularly preferably at least > 1% by weight.

In the case of high Al_2O_3 contents, i.e. contents of > 21% by weight, the SrO content can be varied within wider limits, between 2.6 and < 8% by weight. As a result of, in particular, the high SrO contents which have now become possible, particularly crystallization-stable glasses having sufficiently low densities are obtained. In the case of these glasses, the minimum sum of SrO and BaO is likewise > 3% by weight. These glasses have coefficients of thermal expansion $\alpha_{20/300}$ of between $2.8 \cdot 10^{-6}$/K and $3.6 \cdot 10^{-6}$/K.

The glasses may contain up to 2% by weight of ZnO, preferably < 2% by weight of ZnO. The network modifier ZnO has a structure-loosening function and has less effect on the thermal expansion than the alkaline earth metal oxides. Its effect on the viscosity characteristic line is similar to that of B_2O_3. In particular in the case of processing of the glasses by the float process, the ZnO level is preferably limited to a maximum of 1.5% by weight. Higher levels would increase the risk of unwanted ZnO coatings on the glass surface which may form by evaporation and subsequent condensation in the hot-shaping range.

The glasses are alkali-free. The term "alkali-free" as used herein means that they are essentially free from alkali metal oxides, although they can contain impurities of less than 1000 ppm.

The glasses may contain up to 2% by weight of ZrO_2 + TiO_2, where both the TiO_2 content and the ZrO_2 content

can each be up to 2% by weight. ZrO_2 advantageously increases the heat resistance of the glasses. Owing to its low solubility, ZrO_2 does, however, increase the risk of ZrO_2-containing melt relicts, so-called zirconium nests, in the glass. ZrO_2 is therefore preferably omitted. Low ZrO_2 contents originating from corrosion of zirconium-containing trough material are entirely unproblematic. TiO_2 advantageously reduces the solarization tendency, i.e. the reduction in transmission in the visible wavelength region because of UV-VIS radiation. At contents of greater than 2% by weight, colour casts can occur due to complex formation with Fe^{3+} ions which are present in the glass at low levels as a result of impurities of the raw materials employed.

The glasses may contain conventional refining agents in the usual amounts: they may thus contain up to 1.5% by weight of As_2O_3, Sb_2O_3, SnO_2 and/or CeO_2. It is likewise possible to add 1.5% by weight each of Cl^- (for example in the form of $BaCl_2$), F^- (for example in the form of CaF_2) or SO_4^{2-} (for example in the form of $BaSO_4$). The sum of As_2O_3, Sb_2O_3, CeO_2, SnO_2, Cl^-, F^- and SO_4^{2-} should, however, not exceed 1.5% by weight.

If the refining agents As_2O_3 and Sb_2O_3 are omitted, these glasses can be processed not only using a variety of drawing methods, but also by the float method.

For example with regard to easy batch preparation, it is advantageous to be able to omit both ZrO_2 and SnO_2 and still obtain glasses having the property profile mentioned above, in particular having high heat and chemical resistance and low crystallization tendency.

Working examples:

Glasses were produced in Pt/Ir crucibles at 1620°C from conventional raw materials which were essentially alkali-free apart from unavoidable impurities. The melt was refined at this temperature for one and a half hours, then transferred into inductively heated platinum crucibles and stirred at 1550°C for 30 minutes for homogenization.

The Table shows fourteen examples of glasses according to the invention with their compositions (in % by weight, based on oxide) and their most important properties. The refining agent SnO_2 (Examples 1, 2, 4, 5, 7, 8, 10-14) or As_2O_3 (Examples 3, 6, 9) at a level of 0.3% by weight is not listed. The following properties are given:

- the coefficient of thermal expansion $\alpha_{20/300}$ [10^{-6}/K]
- the density ρ [g/cm^3]
- the dilatometric glass transition temperature T_g [°C] in accordance with DIN 52324
- the temperature at a viscosity of 10^4 dPas (referred to as T 4 [°C])
- the temperature at a viscosity of 10^2 dPas (referred to as T 2 [°C]), calculated from the Vogel-Fulcher-Tammann equation
- the refractive index n_d
- the resistance to buffered hydrofluoric acid ("BHF") as weight loss (material removal value) from glass plates measuring 50 mm × 50 mm × 2 mm and polished on all sides after treatment with 10% strength $NH_4F \cdot HF$ solution for 20 minutes at 23°C [mg/cm^2].

Table

Examples: Compositions (in % by weight, based on oxide) and essential properties of glasses according to the invention.

	1	2	3	4	5	6	7
SiO_2	58.3	58.3	63.5	62.1	62.1	63.5	60.8
B_2O_3	8.5	8.5	9.0	8.2	8.2	9.1	8.2
Al_2O_3	21.5	21.5	16.5	19.0	19.0	17.3	16.1
MgO	4.5	6.0	4.5	6.0	7.5	6.0	4.1
CaO	3.4	1.9	3.0	1.5	1.5	1.8	7.0
SrO	3.5	3.5	3.2	2.0	1.0	2.0	3.5
BaO	-	-	-	0.4	0.4	-	-
ZnO	-	-	-	0.5	-	-	-
$\alpha_{20/300}$ [10^{-6}/K]	3.26	3.16	3.14	2.96	2.99	2.98	3.76
ρ [g/cm^3]	2.48	2.47	2.43	2.45	2.44	n.m.	2.49
T_g [°C]	735	737	723	740	729	725	713
T4 [°C]	1257	1273	1300	1283	1288	1289	1255
T2 [°C]	1613	1621	1694	1657	1652	1653	1616
n_d	1.522	1.522	1.513	1.516	1.516	1.520	1.524
BHF [mg/cm^2]	0.71	0.77	0.58	0.65	0.66	0.60	0.60

n.m. = not measured

Continuation of table:

	8	9	10	11	12	13	14
SiO_2	59.5	60.0	60.0	52.5	60.0	60.0	62.6
B_2O_3	7.5	7.5	6.6	7.5	7.5	10.0	8.2
Al_2O_3	21.5	21.5	22.5	18.5	18.5	16.0	14.5
MgO	4.5	4.1	6.0	4.5	5.6	4.2	4.2
CaO	0.4	3.5	1.1	3.2	4.2	6.0	6.7
SrO	6.0	2.7	3.5	3.5	3.9	3.5	3.5
BaO	0.3	0.4	-	-	-	-	-
ZnO	-	-	-	-	-	-	-
$\alpha_{20/300}$ [10^{-6}/K]	3.04	3.12	3.00	3.19	3.55	3.64	3.72
ρ [g/cm^3]	2.49	2.47	2.48	2.46	2.50	2.47	2.47
T_g [°C]	742	746	753	730	730	700	705
T4 [°C]	1287	1284	1286	1294	1253	1234	1252
T2 [°C]	1654	1644	1641	1674	1615	1604	1627
n_d	1.518	1.520	1.521	1.522	1.524	1.521	1.520
BHF [mg/cm^2]	0.81	0.66	0.78	n.m.	n.m.	n.m.	0.58

Furthermore, acid resistance was determined for the glasses of examples 3 and 14, i.e. the "HCl" acid resistance as weight loss (material removal value) from glass plates measuring 50 mm × 50 mm × 2 mm and polished on all sides after treatment with 5% strength hydrochloric acid for 24 hours at 95°C: it was found to be 0.78 mg/cm^2 (glass no. 3) and 0.50 mg/cm^2 (glass no. 14), respectively.

As the working examples illustrate, the glasses according to the invention have the following advantageous properties:

- a thermal expansion $\alpha_{20/300}$ of between $2.8 \cdot 10^{-6}/K$ and $3.8 \cdot 10^{-6}/K$, or between $2.8 \cdot 10^{-6}/K$ and $3.6 \cdot 10^{-6}/K$, or up to $3.4 \cdot 10^{-6}/K$, respectively, thus matched to the expansion behaviour of both amorphous silicon and increasingly polycrystalline silicon.

- $T_g > 700°C$, a very high glass transition temperature, i.e. a high heat resistance. This is essential for the lowest possible compaction as a result of production and for use of the glasses as substrates for coatings with amorphous Si layers and their subsequent annealing.

- $\rho < 2.500\ g/cm^3$, a low density

- a temperature at a viscosity of 10^4 dPas of at most 1350°C, and a temperature at a viscosity of 10^2 dPas of at most 1720°C, which means a suitable viscosity characteristic line with regard to hot-shaping and meltability. The glasses can be produced as flat glasses by the various drawing methods, for example microsheet down-draw, up-draw or overflow fusion methods, and, in a preferred embodiment, if they are free from As_2O_3 and Sb_2O_3, also by the float process.

- a high chemical resistance, as is evident from good resistance to buffered hydrofluoric acid solution, which makes them sufficiently inert to the chemicals used in the production of flat-panel screens.

- $n_d \leq 1.526$, a low refractive index. This property is the physical prerequisite for a high transmission.

The glasses have high thermal shock resistance and good devitrification stability.

The glasses are thus highly suitable for use as substrate glass in display technology, in particular for TFT displays, and in thin-film photovoltaics.

ABSTRACT

The invention relates to an alkali-free aluminoborosilicate glass having a coefficient of thermal expansion $\alpha_{20/300}$ of between $2.8 \cdot 10^{-6}$/K and $3.8 \cdot 10^{-6}$/K, which has the following composition (in % by weight, based on oxide): SiO_2 > 58 - 65, B_2O_3 > 6 - 11.5, MgO 4 - 8, BaO 0 - < 0.5, ZnO 0 - 2 and Al_2O_3 > 14 - 25, CaO 0 - 8, SrO 2.6 - < 4, with BaO + SrO > 3, or Al_2O_3 > 14 - 25, CaO 0 - < 2, SrO > 0.5 - < 4, or Al_2O_3 > 21 - 25, CaO 0 - 8, SrO > 2.6 - < 8, with BaO + SrO > 3, and which is highly suitable for use as a substrate glass both in display technology and in thin-film photovoltaics.